Claims

We claim:

1. A model stored in a memory describing a transcoded video, comprising:

a first rate-distortion function modeling a requantization of an input video corresponding to the transcoding video;

a second-rate distortion function modeling a resynchronization marker insertion rate for the transcoded video; and

a third rate-distortion function modeling an intra-block insertion rate for the transcoded video.

2. The model of claim 1, further comprising:

a bit allocation control module configured to receive the input video and allocating bits to the transcoded video according to outputs of the first, second, and third models.

3. The model of claim 1, in which the first function outputs a quantization parameter, the second function outputs the resynchronization marker insertion rate, and the third function outputs the intra-block insertion rate.

4. The model of claim 1, in which inter-frame dependencies in the transcoded video are due to a requantization distortion in a current frame of the transcoded video that is propagated to a next frame of the transcoded video through motion compensation, and further comprising:

the first model is modified for the next frame to account for propagating the requantizing distortion.

5. The model of claim 4, in which the input video has a first bit rate greater than a second bit rate of the transcoded video.

6. The model of claim 5, in which the distortion D is expressed as

$$D = [\prod_{i=0}^{L-1} \Phi(\omega_i)]^{1/L} \cdot e^{-\beta \cdot R(D)},$$

where L is a total number of frequency coefficients of a discrete cosine transform in the input video, $\Phi(\omega_i)$ is a power spectrum density function of coefficient i, R is the second bit rate, and β is 2ln2.

7. The model of claim 6, in which β is a variable, $R(D)$ is replaced by $R^{\gamma}(D)$, where λ is a Lagrange multiplier, and $[\prod_{i=0}^{L-1} \Phi(\omega_i)]^{1/I}$ is replaced by a variance σ^2, so that the distortion is

$$D = \sigma_k^2 e^{-\beta R^{\lambda}(D)}.$$

8. The model of claim 7, in which β is in a range of [1, 10], and γ is in a range of [0, 1], so that the distortion is

$$D_0 = \sigma_0^2 e^{-\beta_0 R_0^{\gamma 0}},$$

where D_0 is a distortion of an intra-coded frame of the transcoded video caused by the requantization, and R_0 is the first bit rate.

9. The model of claim 8, further comprising:

means for estimating β and γ from two sample points on the rate-distortion functions.

10. The model of claim 8, in which the allocating operates on groups-of-frames of the transcoded video to account for inter-frame dependencies in the input video due to a requantization distortion in a current frame of the output video that is propagated to a next frame of the output through motion compensation, and further comprising:

means for changing the variance σ^2_k to σ^{*2}_k to model the inter-frame dependency, and a distortion of requantized inter-frames is

$$D_k = \sigma_k^{*2} e^{-\beta_k R_k^7} = (\sigma_k^2 + \alpha_k D_{k-1}) e^{-\beta_k R_k^7}, \quad k = 1, 2, \ldots, N-1,$$

where $\sigma^{*2}_k = \sigma^2_k + \alpha_k D_{k-1}$, and D_k - 1 denotes a quantization residue error produced when a previous frame of the input video is requantized with a larger quantization-scale, α_k denotes a propagation ratio, which is determined by an amount of motion compensation, and $\alpha_k D_{k-1}$ models the inter-frame dependency between the current and the previous frame.

11. The model of claim 1, in which the bits allocated for inserting the resynchronization markers is determined from a number of bits in a resynchronization header and a resynchronization marker spacing, and the bits allocated for inserting the intra-blocks is determined from an intra-block insertion rate and an average rate increase by replacing inter-coded block with intra-blocks.